

CASIO.

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SUPER-FX

fx-3600P_V

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fx-3600P_V

العربية

SA10018428A

Printed in Japan
Imprimé au Japon

ENGLISH

ESPAÑOL

FRANÇAIS

中文

한국어

BAHASA

INDONESIA

英西仏中韓印ア

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41

81

121

162

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x^y	Power	20
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RAND	Random number	21
${}^nP_r$	Permutation	22
${}^nC_r$	Combination	22

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Dear customer,

Thank you very much for purchasing our electronic calculator.

To fully utilize its features no special training is required, but we suggest you study this operation manual to become familiar with its many abilities. To help ensure its longevity, do not touch the inside of the calculator, avoid hard knocks and unduly strong key pressing. Extreme cold (below 32°F or 0°C), heat (above 104°F or 40°C) and humidity may also affect the functions of the calculator. Never use volatile fluid such as lacquer thinner, benzine, etc. when cleaning the unit. For servicing contact your retailer or nearby dealer.

Before starting calculation, be sure to press the **ON** key and to confirm that "0." is shown on the display.

**Special care should be taken not to damage the unit by bending or dropping. For example, do not carry it in your hip pocket.*

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1/GENERAL GUIDE

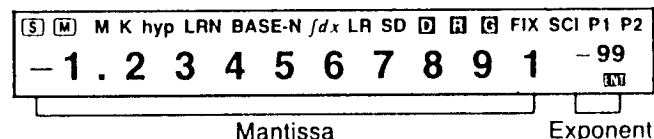
1-1 Modes

To put the calculator into a desired operating mode, or to select a specific angular unit, press **MODE** first, then **[D]**, **[EXP]**, **[0]**, **[1]**,... or **[9]**.

- MODE** **[0]** - RUN mode. Carry out manual calculation and program execution.
- MODE** **[EXP]** - LRN is displayed. Program can be written.
- MODE** **[0]** - BASE-N is displayed. Carry out Binary/octal/decimal/hexadecimal conversions, calculations and logical operations.
- MODE** **[1]** - $\int dx$ is displayed. Integral can be carried out.
- MODE** **[2]** - LR is displayed. Calculate regression analysis.
- MODE** **[3]** - SD is displayed. Calculate standard deviation.
- MODE** **[4]** - **[D]** is displayed. Use degrees as the unit of angle measurement.
- MODE** **[5]** - **[R]** is displayed. Use radians as the unit of angle measurement.
- MODE** **[6]** - **[G]** is displayed. Use grads as the unit of angle measurement.
- MODE** **[7]** - Press any number from 0 to 9 to indicate how many decimal places you want displayed (FIX is displayed).

- MODE** **[8]** - Press any number from 1 (1 digit) to 0 (10 digits) to indicate how many significant digits you want displayed (SCI is displayed).
- MODE** **[9]** - Releases instructions entered in **MODE** **[7]** and **MODE** **[8]**. This operation also changes the range of the exponent display (see page 6).

1-2 The display



The display shows input data, interim results and answers to calculations. The mantissa section displays up to 10 digits. The exponent section displays up to ± 99 .

- E- or -C- Error indication (see page 9).
- [S]** Pressing of **[SHIFT]** (see page 12).
- [M]** Pressing of **MODE** (see page 5).
- M Something is being stored in the memory (see page 11).
- K A constant is being used in calculations (see page 11).
- hyp Pressing of **[hyp]** (see page 19).
- LRN Learn mode (for programming) (see page 29).
- BASE-N BASE-N mode (see page 15).
- $\int dx$ Integral calculation (see page 36).
- LR Regression analysis calculation (see page 25).
- SD Standard deviation calculation (see page 23).
- [D]** or **[R]** or **[G]** Angular unit (see page 18).
- FIX Decimal places of a displayed value is being designated (see page 21).
- SCI Significant digits of a displayed value is being designated (see page 21).
- P1 Indicates current program area is P1 (see page 29).
- P2 Indicates current program area is P2 (see page 29).
- [ENT]** You have just entered variable data into a program or it is time for you to enter variable data (see page 30).
- 45.12.23. 45-12/23 (see page 13).
- 12°3'45.6 12°3'45.6" (see page 18).

■ Exponential Displays

The display can show calculation results only up to 10 digits long. When an intermediate value or a final result is longer, the calculator automatically switches over to exponential notation. Values greater than 9,999,999,999 are always displayed exponentially, while the lower limit is selectable. Note the following:

Type	Lower limit	Upper limit
A (Norm 1)	0.01	9,999,999,999
B (Norm 2)	0.000000001	9,999,999,999

Values less than the lower limits or greater than the upper limit shown above are displayed using exponential format.

Use the following procedure to switch between the Type A lower limit and the Type B lower limit:

- Check the display to see if the FIX or SCI symbols are shown, indicating that the number of significant digits or the number of decimal places have been specified. If either of the symbols is shown, press **MODE** **9** to cancel the specification.

- Perform the following calculation:

1 **200**

- Look at the display to see what the current lower limit is.

If the display reads:

5. ⁰³, the current setting is Type A

5. ⁰³

If the display reads:

0.005, the current setting is Type B

0.005

- Press **MODE** **9** to switch between the Type A and Type B lower limits.

*Note that the lower limit is not changed if you press **MODE** **9** while the number of significant digits (SCI displayed) and/or the number of decimal places (FIX displayed) are specified. The first time you press **MODE** **9**, you clear the FIX and SCI specifications, and so you must press **MODE** **9** again to change the lower limit.

2/ORDER OF OPERATIONS AND LEVELS

Operations are performed in the following order of precedence:

- | | | |
|--|------------------|---------------|
| 1. Functions | 4. +, - | } BASE-N mode |
| 2. x^y , $x^{1/y}$, $R \rightarrow P$, $P \rightarrow R$, nPr , nCr | 5. AND | |
| 3. $\times$, $\div$ | 6. OR, XOR, XNOR | |

Operations with the same precedence are performed from left to right, with operations enclosed in parentheses performed first. If parentheses are nested, the operations enclosed in the innermost set of parentheses are performed first.

*Registers L₁ through L₆ are provided to store operations of lower precedence (including parenthetical operations). Since six registers are provided, calculations up to six levels can be retained.

*Since each level can contain up to three open parentheses, parentheses can be nested up to 18 times.

Ex.) (4 levels, 5 nested parentheses)

Operation:

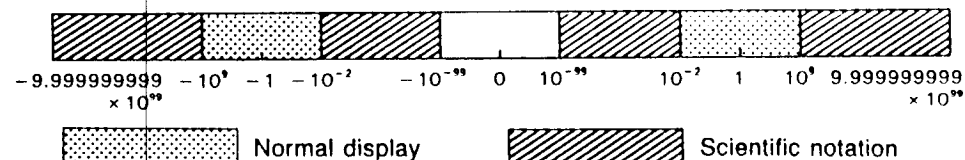
2 **2** **(** **(** **(** **(** **3** **+** **4** ***** **(** **(** **(** **5** **+** **4** **)** **+** **3** **)** **)** **+** **5** **)** **+** **9** **)** **=**

1 level 1 level 1 level 1 level A

Register contents at point A.

x	4
L ₁	(((5 +
L ₂	4 ×
L ₃	((((3 +
L ₄	2 ×
L ₅	
L ₆	

3/CALCULATION RANGE AND SCIENTIFIC NOTATION



When the answer exceeds the normal display capacity, it is automatically shown by scientific notation, 10-digit mantissa and exponents of 10 up to ± 99 .

- 1.234567891 - 99

- The minus (-) sign for mantissa
- The mantissa
- The minus (-) sign for exponent
- The exponent of ten

The whole display is read: $-1.234567891 \times 10^{-99}$

*Entry can be made in scientific notation by using the **EXP** key after entering the mantissa.

EXAMPLE	OPERATION	READ-OUT
---------	-----------	----------

$-1.234567891 \times 10^{-3}$ (= -0.001234567891)

1 234567891 EXP	- 1.234567891
EXP	- 1.234567891 00
3 EXP	- 1.234567891 - 03

4/CORRECTIONS

If you notice an input mistake before you press the arithmetic operation key, simply press **C** to clear the value and enter it again.

In a series of calculations, you can correct errors in intermediate results by recalculating correctly when the error appears and then continuing with the original series from where you interrupted it.

If you make a mistake by pressing the wrong key when entering **+**, **-**, **x**, **÷**, **x²** or **SHIFT** **x²**, simply press the appropriate key to correct. In this case, the most recently pressed key operation is used, but it retains the order of precedence of the original operation entered.

5/OVERFLOW OR ERROR CHECK

Overflow or error is indicated by the "-E-" or "-C -" sign and stops further calculation. **Overflow or error occurs:**

- When an answer, whether intermediate or final, or accumulated total in the memory is more than 1×10^{100} ("-E-" sign appears).
- When function calculations are performed with a number exceeding the input range ("-E-" sign appears).
- When the ranges for any of the number systems used in the BASE-N mode are exceeded. ("-E-" sign appears).
- When unreasonable operations are performed in statistical calculations ("-E-" sign appears).
- When the total number of levels of explicit and/or implicit (with addition-subtraction versus multiplication-division including x^y and $x^{1/y}$) nested parentheses exceeds 6, or more than 18 pairs of parentheses are used ("-C -" sign appears).

Ex.) You have pressed the **EXP** key 18 times continuously before designating the sequence of **2** **+** **3** **x**.

To release these overflow checks:

- a), b), c), d)..... Press the **AC** key.
- e)..... Press the **AC** key. Or press the **C** key, and the intermediate result just before the overflow occurs is displayed and the subsequent calculation is possible.

Memory protection:

The content of the memory is protected against overflow or error and the accumulated total is recalled by pressing the **MR** key after the overflow check is released by the **AC** key.

6/POWER SOURCE

The CASIO C-POWER system makes it possible to operate calculators any place even in complete darkness; you don't have to worry about the light conditions.

*This unit protects memory no matter what the light conditions.

*This unit uses two power sources: an amorphous silicon solar cell, and a lithium battery (GR927).

*A weakened lithium battery is indicated when the memory contents spontaneously clear or when the display darkens under poor light conditions and cannot be restored by pressing the **ON** key. Anytime such symptoms occur, the unit should be taken to your retailer or nearby dealer for battery replacement.

*Lithium battery replacement should only be performed by your retailer or an authorized dealer.

*To ensure proper operation the lithium battery should be replaced once every six years no matter how much the unit is used.

Auto power-off function

This unit automatically switches OFF if not operated for approximately 6 minutes. Power can be restored by pressing the **ON** key. Memory contents and mode setting are retained even when power is switched off.

7/NORMAL CALCULATIONS

*You can perform normal calculations in the RUN mode (**MODE** **□**).

*Calculations can be performed in the same sequence as the written formula (true algebraic logic).

*Nesting of up to 18 parentheses at 6 levels is allowed.

7-1 Four basic calculations (incl. parenthesis calculations)

EXAMPLE	OPERATION	READ-OUT
$23 + 4.5 - 53 =$	23 + 4 . 5 - 53 =	- 25.5
$56 \times (-12) \div (-2.5) =$	56 x 12 . 2 . 5 . =	268.8
$2 \div 3 \times (1 \times 10^{20}) =$	2 ÷ 3 x 1 EXP 20 =	6.666666667 19
$7 \times 8 - 4 \times 5 (= 56 - 20) =$	7 x 8 - 4 x 5 =	36.
$1 + 2 - 3 \times 4 \div 5 + 6 =$	1 + 2 - 3 x 4 ÷ 5 + 6 =	6.6
$\frac{6}{4 \times 5} =$	6 ÷ 4 x 5 =	0.3

*The number of levels of the **()** key can be displayed.

$2 \times (7 + 6 \times (5 + 4)) =$	2 x (7 + 6 x (5 + 4)) =	0.
	7 + 6 x (5 + 4) =	0.
	5 + 4 =	122.

*It is unnecessary to press the **()** key before the **=** key.

$10 - \{7 \times (3 + 6)\} =$	10 - { 7 x (3 + 6) } =	- 53.
-------------------------------	--	-------

Another operation: **10** **-** **{** **7** **x** **(** **3** **+** **6** **)** **}** **=**

7-2 Constant calculations

*The "K" sign appears when a number is set as a constant.

$$3 + 2.3 =$$

$$6 + 2.3 =$$

$$2.3 \times 12 =$$

$$(-9) \times 12 =$$

$$17 + 17 + 17 + 17 =$$

$$1.7^2 =$$

$$1.7^3 =$$

$$1.7^4 =$$

$$3 \times 6 \times 4 =$$

$$3 \times 6 \times (-5) =$$

$$\frac{56}{4 \times (2 + 3)} =$$

$$\frac{23}{4 \times (2 + 3)} =$$

$$2 \square 3 \square + \square + 3 \square \text{K} \quad 5.3$$

$$6 \square \text{K} \quad 8.3$$

$$12 \square \square 2 \square 3 \square \text{K} \quad 27.6$$

$$9 \square \text{K} \quad -108.$$

$$17 \square + \square + \square \text{K} \quad 34.$$

$$\square \text{K} \quad 51.$$

$$\square \text{K} \quad 68.$$

$$1 \square 7 \square \square \text{K} \quad 2.89$$

$$\square \text{K} \quad 4.913$$

$$\square \text{K} \quad 8.3521$$

$$3 \square 6 \square \square \text{K} \quad 18.$$

$$4 \square \text{K} \quad 72.$$

$$5 \square \text{K} \quad -90.$$

$$4 \square \square 2 \square + 3 \square \square \text{K} \quad 20.$$

$$56 \square \text{K} \quad 2.8$$

$$23 \square \text{K} \quad 1.15$$

7-3 Memory calculations using the independent memory

*When a new number is entered into the independent memory by the $\square$ (SHIFT) (Min) key, the previous number stored is automatically cleared and the new number is put in the independent memory.

*The "M" sign appears when a number is stored in the independent memory.

*The contents accumulated into the independent memory are preserved even after the power switch is turned off.

To clear the contents press $\square$ (SHIFT) (Min) or $\square$ (SHIFT) (Min) in sequence.

$$53 + 6 = 59$$

$$23 - 8 = 15$$

$$56 \times 2 = 112$$

$$+) 99 \div 4 = 24.75$$

$$210.75$$

$$53 \square + 6 \square \text{M} \quad 59.$$

$$23 \square - 8 \square \text{M} \quad 15.$$

$$56 \square \times 2 \square \text{M} \quad 112.$$

$$99 \square \div 4 \square \text{M} \quad 24.75$$

$$\square \text{M} \quad 210.75$$

$$7 + 7 - 7 + (2 \times 3) + (2 \times 3) + (2 \times 3) - (2 \times 3) =$$

$$7 \square \text{SHIFT} \square \text{Min} \square + \square \text{SHIFT} \square \text{Min} \square - \square 2 \square \times \square 3 \square + \square \text{M} \square + \square \text{M} \square \text{SHIFT} \square \text{Min} \square \text{MR} \quad \text{M} \quad 19.$$

$$12 \times 3 = 36$$

$$-) 45 \times 3 = 135$$

$$78 \times 3 = 234$$

$$135$$

$$3 \square \times \square 12 \square \text{SHIFT} \square \text{Min} \quad \text{M K} \quad 36.$$

$$45 \square \text{SHIFT} \square \text{M} \quad \text{M K} \quad 135.$$

$$78 \square \text{M} \quad \text{M K} \quad 234.$$

$$\square \text{MR} \quad \text{M K} \quad 135.$$

7-4 Memory calculations using 6 constant memories

*When a new number is entered into a constant memory by operating ENTRY $\square$ (K.in) ($\square$ to $\square$), the previous number stored is automatically cleared and the new number is put in the constant memory.

*The contents stored in the constant memories are preserved even after the power switch is turned off.

To clear the contents press $\square$ (K.in) ($\square$ to $\square$) or $\square$ (K.in) ($\square$ to $\square$) in sequence.

$$193.2 \div 23 =$$

$$193 \square \div 2 \square \text{K.in} \square 1 \square \div 23 \square \quad 8.4$$

$$193.2 \div 28 =$$

$$\square \text{K.out} \square 1 \square \div 28 \square \quad 6.9$$

$$193.2 \div 42 =$$

$$\square \text{K.out} \square 1 \square \div 42 \square \quad 4.6$$

*Another operations by using the independent memory:

$$193 \square \div 2 \square \text{SHIFT} \square \text{Min} \square \div 23 \square, \square \text{MR} \square \div 28 \square, \square \text{MR} \square \div 42 \square$$

$$\frac{9 \times 6 + 3}{(7 - 2) \times 8} =$$

$$9 \square \times 6 \square + 3 \square \text{K.in} \square 1 \quad 57.$$

$$\square - 7 \square - 2 \square \square \times 8 \square \text{K.in} \square 2 \quad 40.$$

$$\square \text{K.out} \square 1 \square \div \square \text{K.out} \square 2 \square \quad 1.425$$

*Calculations in constant memory registers can also be performed by using the $\square$, $\square$, $\square$ and $\square$ keys.

$$7 \times 8 \times 9 = 504$$

$$4 \times 5 \times 6 = 120$$

$$3 \times 6 \times 9 = 162$$

$$(\text{Total}) 14 \quad 19 \quad 24 \quad 786$$

$$7 \square \text{K.in} \square 1 \square \times 8 \square \text{K.in} \square 2 \square \times 9 \square \text{K.in} \square 3 \square \text{SHIFT} \square \text{Min} \quad \text{M} \quad 504.$$

$$4 \square \text{K.in} \square + \square 1 \square \times 5 \square \text{K.in} \square + \square 2 \square \times 6 \square \text{K.in} \square + \square 3 \square \text{M} \quad 120.$$

3	Kin	+	1	X	6	Kin	+	2	X	9	Kin	+	3	M+	M	162.		
															Kout	1	M	14.
															Kout	2	M	19.
															Kout	3	M	24.
															MR		M	786.

$$12 \times (2.3 + 3.4) - 5 =$$

$$30 \times (2.3 + 3.4 + 4.5) - 15 \times 4.5 =$$

$$12 \times (2.3 + 3.4 + 4.5) - 15 \times 4.5 = 63.4$$

$$30 \times 4.5 - 15 \times 4.5 = 238.5$$

To exchange the displayed number (4.5) with the contents of constant memory 1.

7-5 Fraction calculations

* Total of integer, numerator and denominator must be within 10 digits (includes division marks).

* A fraction can be transferred to the memory.

* When a fraction is extracted, the answer is displayed as a decimal.

* A press of $\frac{\square}{\square}$ key after the $\frac{\square}{\square}$ key converts the fraction answer to the decimal scale.

$$4\frac{5}{6} \times (3\frac{1}{4} + 1\frac{2}{3}) \div 7\frac{8}{9} =$$

$$4 \frac{5}{6} \times (3 \frac{1}{4} + 1 \frac{2}{3}) \div 7 \frac{8}{9} = 3.71568.$$

$$3.012323944$$

$$3.71568.$$

$$2\frac{4}{5} + \frac{3}{4} - 1\frac{1}{2} =$$

$$2 \frac{4}{5} + \frac{3}{4} - 1 \frac{1}{2} = 3.1120.$$

$$3.55$$

$$1 \frac{1}{2} \div 2 = 2.120.$$

$$(1.5 \times 10^7) - \{(2.5 \times 10^6) \times \frac{3}{100}\} =$$

$$1.5 \times 10^7 - \{(2.5 \times 10^6) \times \frac{3}{100}\} = 14925000.$$

* During a fraction calculation, a figure is reduced to the lowest terms by pressing a function command key ($\frac{\square}{\square}$, $\frac{\square}{\square}$, $\frac{\square}{\square}$ or $\frac{\square}{\square}$) or the $\frac{\square}{\square}$ key if the figure is reducible.

$$3\frac{456}{78} = 8\frac{11}{13} \text{ (Reduction)}$$

$$3 \frac{456}{78} = 3.456178.$$

$$8.1113.$$

* By pressing $\frac{\square}{\square}$ continuously, the displayed value will be converted to the improper fraction.

$$\text{Continuing from above } \frac{\square}{\square} = 115.13.$$

$$\frac{12}{45} - \frac{32}{56} =$$

$$12 \frac{45}{45} - 32 \frac{56}{56} = 4.15.$$

$$-32.105.$$

* The answer in a calculation performed between a fraction and a decimal is displayed as a decimal.

$$\frac{41}{52} \times 78.9 =$$

$$41 \frac{52}{52} \times 78.9 = 41.52.$$

$$62.20961538$$

7-6 Percentage calculations

12% of 1500

$$1500 \times 12 \frac{\square}{\square} = 180.$$

Percentage of 660 against 880

$$660 \div 880 \frac{\square}{\square} = 75.$$

15% add-on of 2500

$$2500 \times 15 \frac{\square}{\square} = 2875.$$

25% discount of 3500

$$3500 \times 25 \frac{\square}{\square} = 2625.$$

300cc is added to a solution of 500cc. What is the percent of the new volume to the initial one?

$$300 \div 500 \frac{\square}{\square} = 160.$$

(%)

If you made \$80 last week and \$100 this week, what is the percent increase?

$$100 - 80 \frac{\square}{\square} = 25.$$

(%)

12% of 1200

$$1200 \times 12 \frac{\square}{\square} = 144.$$

18% of 1200

$$18 \frac{\square}{\square} = 216.$$

23% of 1200

$$23 \frac{\square}{\square} = 276.$$

26% of 2200

$$26 \times 2200 \frac{\square}{\square} = 572.$$

26% of 3300

$$3300 \frac{\square}{\square} = 858.$$

26% of 3800

$$3800 \frac{\square}{\square} = 988.$$

Percentage of 30 against 192

$$192 \div 30 \frac{\square}{\square} = 15.625$$

Percentage of 156 against 192

$$156 \frac{\square}{\square} = 81.25$$

- *600 grams was added to 1200 grams. What percent is the total to the initial weight?
 *510 grams was added to 1200 grams. What percent is the total to the initial weight?

1200 **+** 600 **SHIFT** **%** **K** 150.
 510 **SHIFT** **%** **K** 142.5

- *How many percent down is 138 grams to 150 grams?
 *How many percent down is 129 grams to 150 grams?

150 **-** 138 **SHIFT** **%** **K** - 8.
 129 **SHIFT** **%** **K** - 14.

8/BINARY/OCTAL/DECIMAL/HEXADECIMAL CALCULATIONS

- Binary/octal/decimal/hexadecimal calculations and conversions are performed in the BASE-N mode (**MODE** **0**).
- Base values are set by pressing one of the following keys:

KEY	BASE
DEC	Decimal
HEX	Hexadecimal
SHIFT BIN	Binary
SHIFT OCT	Octal

- Calculation range

BASE	DIGITS	RANGE
Binary	10 digits	Positive : $0 \leq x \leq 111111111$ Negative: $1000000000 \leq x \leq 1111111111$
Octal	10 digits	Positive : $0 \leq x \leq 3777777777$ Negative: $4000000000 \leq x \leq 7777777777$
Decimal	10 digits	Positive : $0 \leq x \leq 2147483647$ Negative: $-2147483648 \leq x < 0$
Hexadecimal	8 digits	Positive : $0 \leq x \leq 7FFFFFFF$ Negative: $80000000 \leq x \leq FFFFFFFF$

- Valid values

BASE	VALUES
Binary:	0, 1
Octal:	0, 1, 2, 3, 4, 5, 6, 7
Decimal:	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
Hexadecimal:	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

- *Values other than noted above cannot be entered while each respective base is in effect. The letters B and D are displayed in lower case for hexadecimal.
 *You cannot specify the unit of angular measurement (degrees, radians, grads) or the display format (FIX, SCI) while the calculator is in the BASE-N mode. Such specifications can only be made if you first exit the BASE-N mode.

8-1 Binary/octal/decimal/hexadecimal conversions

MODE **0** (BASE-N mode)

Conversion of 22_{10} to binary

DEC 22 **SHIFT** **BIN** 10110. ^b

Conversion of 22_{10} to octal

SHIFT **OCT** 26. ^o

Conversion of 22_{10} to hexadecimal

HEX 16. ^h

Conversion of 513_{10} to binary

DEC 513 **SHIFT** **BIN** -E- ^b

*Conversion may sometimes be impossible if calculation range of original value is greater than range of result value.

Conversion of $7FFFFFFF_{16}$ to decimal

HEX 7FFFFFFF **DEC** 2147483647. ^d

Conversion of 4000000000_8 to decimal

SHIFT **OCT** 4000000000 **DEC** - 536870912. ^d

Conversion of 123456_{10} to octal

DEC 123456 **SHIFT** **OCT** 361100. ^o

Conversion of 1100110_2 to decimal

SHIFT **BIN** 1100110 **DEC** 102. ^d

8-2 Negative expressions

- Negative values can be obtained by pressing the **NEG** key. The two's complement is produced for negation of binary, octal, decimal and hexadecimal values.

MODE **0** (BASE-N mode)

Negation of 1010_2

SHIFT **BIN** 1010 **NEG** 111110110. ^b

Conversion to decimal

DEC - 10. ^d

Negation of 1_2

SHIFT **BIN** 1 **NEG** 111111111. ^b

Negation of 2_8

SHIFT **OCT** 2 **NEG** 777777776. ^o

Negation of 34_{16}

HEX 34 **NEG** FFFFFFFC. ^h

8-3 Binary/octal/decimal/hexadecimal calculations

- Memory and parenthesis calculations can be used with binary, octal, decimal and hexadecimal number systems.

MODE **0** (BASE-N mode)

$10111_2 + 11010_2 = 110001_2$

SHIFT **BIN** 10111 **+** 11010 **=** 110001. ^b

$123_8 \times ABC_{16} = 37AF4_{16}$
 $= 228084_{10}$

SHIFT **OCT** 123 **×** **HEX** ABC **=** 37AF4. ^h
DEC 228084. ^d

$$1F2D_{16} - 100_{10} = 7881_{10}$$

$$= 1EC9_{16}$$

HEX	1F2D	DEC	100	=	7881.	^d
HEX				=	1EC9.	^h

$$7654_8 \div 12_{10} = 334.3\cdots_{10}$$

$$= 516_8$$

SHIFT	OCT	7654	DEC	12	=	334.	^d
SHIFT	OCT				=	516.	^o

*Fractional parts of calculation results are truncated.

$$110_2 + 456_8 \times 78_{10} \div 1A_{16} = 390_{16}$$

$$= 912_{10}$$

SHIFT	BIN	110	+	SHIFT	OCT	456	$\times$	DEC	78	$\div$	HEX	1A	=	390.	^h
													=	912.	^d

*Multiplication and division are given priority over addition and subtraction in mixed calculations.

$$BC_{16} \times (14_{10} + 69_{10}) = 15604_{10}$$

$$= 3CF4_{16}$$

HEX	BC	$\times$	(	DEC	14	+	69	)	=	15604.	^d
HEX									=	3CF4.	^h

$$23_8 + 963_{10} = 982_{10}$$

SHIFT	OCT	23	+	SHIFT	MAR	963	=	982.	^d
-------	-----	----	---	-------	-----	-----	---	------	--------------

$$23_8 + 101011_2 = 111110_2$$

MAR	+	SHIFT	BIN	101011	=	111110.	^b
-----	---	-------	-----	--------	---	---------	--------------

$$2A56_{16} \times 23_8 = 32462_{16}$$

HEX	2A56	$\times$	MAR	23	=	32462.	^h
-----	------	----------	-----	----	---	--------	--------------

8-4 Logical operations

*The **AND**, **OR**, **XOR**, **XNOR** and **NOT** keys can be used to perform the respective binary, octal, decimal and hexadecimal logical operations.

MODE **0** (BASE-N mode)

$$19_{16} \text{ AND } 1A_{16} = 18_{16}$$

HEX	19	AND	1A	=	18.	^h
-----	----	-----	----	---	-----	--------------

$$1110_2 \text{ AND } 36_8 = 1110_2$$

SHIFT	BIN	1110	AND	SHIFT	OCT	36	=	16.	^o	
									1110.	^b

$$23_8 \text{ OR } 61_8 = 63_8$$

SHIFT	OCT	23	OR	61	=	63.	^o
-------	-----	----	----	----	---	-----	--------------

$$120_{16} \text{ OR } 1101_2 = 12D_{16}$$

HEX	120	OR	SHIFT	BIN	1101	=	100101101.	^b
HEX						=	12D.	^h

$$5_{16} \text{ XOR } 3_{16} = 6_{16}$$

HEX	5	XOR	3	=	6.	^h
-----	---	-----	---	---	----	--------------

$$2A_{16} \text{ XNOR } 5D_{16} = FFFFFFF8_{16}$$

HEX	2A	XNOR	5D	=	FFFFFFF8.	^h
-----	----	------	----	---	-----------	--------------

$$1010_2 \text{ AND } (A_{16} \text{ OR } 7_{16}) = 1010_2$$

SHIFT	BIN	1010	AND	(	HEX	A	OR	7	)	=	A.	^h
										=	1010.	^b

$$1A_{16} \text{ AND } 2F_{16} = A_{16}$$

HEX	2F	AND	1A	=	A.	^h
-----	----	-----	----	---	----	--------------

$$3B_{16} \text{ AND } 2F_{16} = 2B_{16}$$

				=	2B.	^h
--	--	--	--	---	-----	--------------

$$\text{NOT of } 10110_2$$

SHIFT	BIN	10110	NOT	=	1111101001.	^b
-------	-----	-------	-----	---	-------------	--------------

$$\text{NOT of } 1234_8$$

SHIFT	OCT	1234	NOT	=	7777776543.	^o
-------	-----	------	-----	---	-------------	--------------

$$\text{NOT of } 2FFFD_{16}$$

HEX	2FFFD	NOT	=	FFd00012.	^h
-----	-------	-----	---	-----------	--------------

9/FUNCTION CALCULATIONS

Scientific function keys can be utilized as subroutines of four basic calculations (including parenthesis calculations).

*This calculator computes as $\pi = 3.141592654$ and $e = 2.718281828$.

*In some scientific functions, the display disappears momentarily while complicated formulas are being processed. So do not enter numerals or press the function key until the previous answer is displayed.

*You cannot specify the unit of angular measurement (degrees, radians, grads) or the display format (FIX, SCI) while the calculator is in the BASE-N mode. Such specifications can only be made if you first exit the BASE-N mode.

*For each input range of the scientific functions, see page 39.

9-1 Sexagesimal $\leftrightarrow$ Decimal conversion

The **DDD** key converts the sexagesimal figure (degree, minute and second) to decimal notation. Operation of **SHIFT** **DDD** converts the decimal notation to the sexagesimal notation.

$$14^\circ 25' 36'' =$$

14	DDD	=	14.
25	DDD	=	14.41666667
36	DDD	=	14.42666667
SHIFT	DDD	=	14° 25' 36.

9-2 Trigonometric/Inverse trigonometric functions

$$\sin\left(\frac{\pi}{6} \text{ rad}\right) =$$

"R"	(MODE 5)	π	$\div$	6	=	sin	=	0.5
-----	----------	-------	--------	---	---	-----	---	-----

$$\cos 63^\circ 52' 41'' =$$

"D"	(MODE 4)	63	DDD	52	DDD	41	DDD	=	63.87805556
								=	0.440283084

$$\tan(-35 \text{ gra}) =$$

"G"	(MODE 6)	35	$\div$	tan	=	-0.612800788
-----	----------	----	--------	-----	---	--------------

$$2 \cdot \sin 45^\circ \times \cos 65^\circ =$$

$$2 \sin 45^\circ \cos 65^\circ = 0.597672477 \quad \ln 90 (= \log_e 90) =$$

$$90 \ln = 4.49980967$$

$$\cot 30^\circ = \frac{1}{\tan 30^\circ} =$$

$$\cot 30^\circ = 1.732050808 \quad \log 456 \div \ln 456 =$$

$$456 \log \div \ln = 0.434294481$$

$$\sec\left(\frac{\pi}{3} \text{ rad}\right) = \frac{1}{\cos\left(\frac{\pi}{3} \text{ rad}\right)} =$$

$$\sec\left(\frac{\pi}{3}\right) = 2 \quad 10^{0.4} + 5 \cdot e^{-3} =$$

$$10^{0.4} + 5e^{-3} = 2.760821773$$

$$\operatorname{cosec} 30^\circ = \frac{1}{\sin 30^\circ} =$$

$$\operatorname{cosec} 30^\circ = 2 \quad 5.6^{2.3} =$$

$$5.6^{2.3} = 52.58143837$$

$$\cos^{-1} \frac{\sqrt{2}}{2} =$$

$$\cos^{-1} \frac{\sqrt{2}}{2} = 0.785398163 \quad 123^{1/7} (= \sqrt[7]{123}) =$$

$$123^{1/7} = 1.988647795$$

$$\tan^{-1} 0.6104 =$$

$$\tan^{-1} 0.6104 = 31.39989118 \quad (78 - 23)^{-12} =$$

$$(78 - 23)^{-12} = 1.305111829 - 21$$

$$3^{12} + e^{10} = 553467.4658$$

9-3 Hyperbolic functions and inverse hyperbolic functions

$$\log \sin 40^\circ + \log \cos 35^\circ = -0.278567983$$

$$0.526540784$$

$$\sinh 3.6 =$$

$$\sinh 3.6 = 18.28545536$$

(The antilogarithm..... 0.526540784)

$$\tanh 2.5 =$$

$$\tanh 2.5 = 0.986614298$$

$$15^{1/5} + 25^{1/6} + 35^{1/7} =$$

$$15^{1/5} + 25^{1/6} + 35^{1/7} = 5.090557037$$

$$\cosh 1.5 - \sinh 1.5 =$$

$$\cosh 1.5 - \sinh 1.5 = 2.352409615$$

$$0.22313016$$

$$-1.5$$

9-5 Square roots, Cube roots, Squares, Reciprocals & Factorials

$$\sinh^{-1} 30 =$$

$$\sinh^{-1} 30 = 4.094622224$$

$$\sqrt{2} + \sqrt{3} \times \sqrt{5} =$$

$$\sqrt{2} + \sqrt{3} \times \sqrt{5} = 5.287196909$$

$$\text{Solve } \tanh 4x = 0.88.$$

$$x = \frac{\tanh^{-1} 0.88}{4} =$$

$$\tanh^{-1} 0.88 = 0.343941914$$

$$\sqrt[3]{5} + \sqrt[3]{-27} =$$

$$\sqrt[3]{5} + \sqrt[3]{-27} = -1.290024053$$

$$123 + 30^2 =$$

$$123 + 30^2 = 1023$$

$$\frac{1}{\frac{1}{3} - \frac{1}{4}} =$$

$$\frac{1}{\frac{1}{3} - \frac{1}{4}} = 12$$

9-4 Common & Natural logarithms/Exponentiations (Common antilogarithms, Natural antilogarithms, Powers and Roots)

$$\log 1.23 (= \log_{10} 1.23) =$$

$$\log 1.23 = 0.089905111$$

$$\text{Solve } 4^x = 64.$$

$$x \cdot \log 4 = \log 64$$

$$x = \frac{\log 64}{\log 4}$$

$$\frac{\log 64}{\log 4} = 3$$

$$8! (= 1 \times 2 \times 3 \times \dots \times 7 \times 8) =$$

$$8! = 40320$$

9-6 Miscellaneous functions (FIX, SCI, NORM, RND, RAN#, ENG)

$$1.234 + 1.234 =$$

"FIX2" (MODE) (7) (2) 1 . 234 = **1.23**
 1 . 234 = **2.47**
 (MODE) (9) **2.468**
 "FIX2" 1 . 234 (SHIFT) (RND) = **1.23**
 1 . 234 (SHIFT) (RND) = **2.46**
 (MODE) (9) **2.46**

$$1 \div 3 + 1 \div 3 =$$

"SCI2" (MODE) (8) (2) 1 ÷ 3 = **3.3 - 01**
 1 ÷ 3 = **6.7 - 01**
 (MODE) (9) **0.66666666**
 "SCI2" (MODE) (8) (2) 1 ÷ 3 (SHIFT) (RND) = **3.3 - 01**
 1 ÷ 3 (SHIFT) (RND) = **6.6 - 01**
 (MODE) (9) **0.66**

$$1 \div 1000 = 0.001$$

$$= 1 \times 10^{-3}$$

(Norm 1) 1 ÷ 1000 = **1. - 03**
 (Norm 2) (MODE) (9) **0.001**

$$123\text{m} \times 456 = 56088\text{m}$$

$$= 56.088\text{km}$$

123 × 456 = **56088.**
 (ENG) **56.088 03**

$$7.8\text{g} \div 96 = 0.08125\text{g}$$

$$= 81.25\text{mg}$$

7 . 8 ÷ 96 = **0.08125**
 (ENG) **81.25 - 03**

Generate a random number between 0.000 and 0.999.

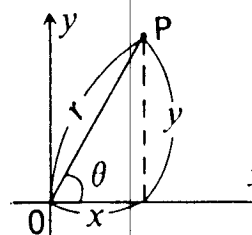
(SHIFT) (RAN#) **0.570**

(Example)

9-7 Polar to rectangular co-ordinates conversion

Formula: $x = r \cdot \cos \theta$ $y = r \cdot \sin \theta$

Ex.) Find the value of x and y when the point P is shown as $\theta = 60^\circ$ and length $r = 2$ in the polar co-ordinates.



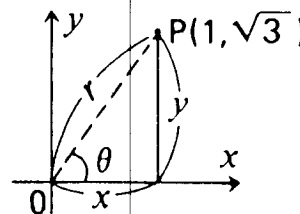
"D" 2 (SHIFT) (P-R) 60 = **1.**
 (x)
 (SHIFT) (X-Y) **1.732050808**
 (y)

9-8 Rectangular to polar co-ordinates conversion

Formula: $r = \sqrt{x^2 + y^2}$

$$\theta = \tan^{-1} \frac{y}{x} \quad (-180^\circ < \theta \leq 180^\circ)$$

Ex.) Find the length r and angle θ in radian when the point P is shown as $x = 1$ and $y = \sqrt{3}$ in the rectangular coordinates.



"R" 1 (SHIFT) (R-P) 3 ✓ = **2.**
 (r)
 (SHIFT) (X-Y) **1.047197551**
 (theta in radian)

9-9 Permutations

Input range: $n \geq r$ (n, r : natural numbers)

Formula: $nPr = \frac{n!}{(n-r)!}$

Ex.) How many numbers of 4 figures can be obtained when permuting 4 different numbers among 7 (1 to 7)?

7 (SHIFT) (nPr) 4 = **840.**

9-10 Combinations

Input range: $n \geq r$ (n, r : natural numbers)

Formula: $nCr = \frac{n!}{r!(n-r)!}$

Ex.) How many groups of 4 members can be obtained when there are ten in class.

10 (SHIFT) (nC) 4 = **210.**

10/STATISTICAL CALCULATIONS

*Be sure to press **[SHIFT]** **[KAC]** in sequence prior to starting a statistical calculation.

10-1 Standard deviation

*Set the function mode to "SD" by pressing **[MODE]** **[3]**.

Ex.) Find σ_{n-1} , σ_n , $\bar{x}$, n , Σx and Σx^2 based on the data 55, 54, 51, 55, 53, 53, 54, 52

"SD" **[SHIFT]** **[KAC]** **55** **[DATA]** **54** **[DATA]** **51** **[DATA]** **55** **[DATA]** **53** **[DATA]** **53** **[DATA]** **54** **[DATA]** **52** **[DATA]** **[]** **52.**

(Sample standard deviation)

[SHIFT] **[xσn-1]** **[]** **1.407885953**

(Population standard deviation)

[SHIFT] **[xσn]** **[]** **1.316956719**

(Arithmetical mean)

[SHIFT] **[x̄]** **[]** **53.375**

(Number of data)

[Kout] **[n]** **[]** **8.**

(Sum of value)

[Kout] **[Σx]** **[]** **427.**

(Sum of square value)

[Kout] **[Σx²]** **[]** **22805.**

Calculate the unbiased variance and the deviation between each data item and the average.

(Subsequently)

[SHIFT] **[xσn-1]** **[SHIFT]** **[x²]** **[]** **1.982142857**

(Unbiased variance)

[SHIFT] **[x̄]** **[]** **55** **[]** **1.625**

(55 - $\bar{x}$)

54 **[]** **0.625**

(54 - $\bar{x}$)

51 **[]** **-2.375**

(51 - $\bar{x}$)

⋮
⋮

Note: The sample standard deviation σ_{n-1} is defined as

$$\sqrt{\frac{\Sigma x^2 - (\Sigma x)^2}{n-1}}$$

the population standard deviation σ_n is defined as

$$\sqrt{\frac{\Sigma x^2 - (\Sigma x)^2}{n}}$$

and the arithmetical mean $\bar{x}$ is defined as

$$\frac{\Sigma x}{n}$$

*Pressing **[xσn-1]**, **[xσn]**, **[x̄]**, **[n]**, **[Σx]** or **[Σx²]** key need not be done sequentially.

Ex.) Find n , $\bar{x}$ & σ_{n-1} based on the data: 1.2, -0.9, -1.5, 2.7, -0.6, 0.5, 0.5, 0.5, 0.5, 1.3, 1.3, 1.3, 0.8, 0.8, 0.8, 0.8, 0.8.

"SD" **[SHIFT]** **[KAC]** **1** **[]** **2** **[DATA]** **9** **[]** **9** **[DATA]** **[]** **-0.9**

① (Mistake)

2 **[]** **5** **[]** **5** **[DATA]** **[]** **-2.5**

①' (To correct)

[C] **[]** **0.**

1 **[]** **5** **[]** **5** **[DATA]** **[]** **-1.5**

2 **[]** **7** **[DATA]** **[]** **2.7**

② (Mistake)

[DATA] **[]** **2.7**

③ (Mistake)

1 **[]** **6** **[]** **5** **[DATA]** **[]** **-1.6**

③' (To correct)

[SHIFT] **[DEL]** **[]** **-1.6**

[] **6** **[]** **5** **[DATA]** **[]** **-0.6**

②' (To correct)

2 **[]** **7** **[SHIFT]** **[DEL]** **[]** **2.7**

[] **5** **[]** **5** **[DATA]** **[]** **0.5**

4 **[DATA]** **[]** **0.5**

④ (Mistake)

1 **[]** **4** **[]** **5** **[DATA]** **[]** **1.4**

④' (To correct)

[AC] **[]** **0.**

1 **[]** **3** **[]** **5** **[DATA]** **[]** **1.3**

[] **8** **[]** **5** **[DATA]** **[]** **0.8**

⑤ (Mistake)

6 **[DATA]** **[]** **0.8**

⑤' (To correct)

8	6	SHIFT	DEL	0.8
8	5	DATA		0.8
Kout	7			17.
SHIFT	7			0.635294117
SHIFT	ON			0.95390066

10-2 Regression analysis

*Set the function mode to "LR" by pressing **MODE** **2**.

Linear regression

Formula: $y = A + Bx$

$$A = \frac{\Sigma y - B \cdot \Sigma x}{n} \quad B = \frac{n \cdot \Sigma xy - \Sigma x \cdot \Sigma y}{n \cdot \Sigma x^2 - (\Sigma x)^2}$$

$$r = \frac{n \cdot \Sigma xy - \Sigma x \cdot \Sigma y}{\sqrt{\{n \cdot \Sigma x^2 - (\Sigma x)^2\} \{n \cdot \Sigma y^2 - (\Sigma y)^2\}}}$$

Ex.) Results from measuring the length and temperature of a steel bar.

temp.	length
10°C	1003mm
15	1005
20	1010
25	1008
30	1014

Find the constant term (A), regression coefficient (B), correlation coefficient (r) and estimated values ($\hat{x}$, $\hat{y}$) using the above figures as a basis.

"LR"

SHIFT	KAC	10	DATA	10.
		1003	DATA	1003.
15	DATA	1005	DATA	1005.
20	DATA	1010	DATA	1010.
25	DATA	1008	DATA	1008.
30	DATA	1014	DATA	1014.
SHIFT	A			998.
SHIFT	B			0.5
				(B)
SHIFT	r			0.919018277
				(r)

(When the temp. is 18°C) 18 **DATA** 1007.

(mm)

(When the length is 1000mm) 1000 **SHIFT** **7** 4.

(°C)

Note: Σx^2 , Σx , n , Σy^2 , Σy , Σxy , $\bar{x}$, $x\sigma_{n-1}$, $x\sigma_{n-1}$, $\bar{y}$, $y\sigma_{n-1}$, $y\sigma_{n-1}$, A, B and r are respectively obtained by pressing a numeral key (**1** to **9**) after the **Kout** or **SHIFT** key.

*Correction of data entry

Ex.)

x_i	2	3	2	3	2	4
y_i	3	4	4	5	5	5

"LR"

SHIFT **KAC** 2 **DATA** 3 **DATA** 3.

① (Mistake)

4 **DATA** 4.

①' (To correct)

C 0.

3 **DATA** 3.

4 **DATA** 4.

② (Mistake)

3 **DATA** 3.

②' (To correct)

2 **DATA** 2.

4 **DATA** 4.

③ (Mistake)

1 **DATA** 1.

5 **DATA** 5.

③' (To correct)

SHIFT **DEL** 5.

3 **DATA** 5 **DATA** 5.

2 **DATA** 2.

④ (Mistake)

4 **DATA** 4.

4 **DATA** 4.

⑤ (Mistake)

6 **DATA** 6.

⑤' (To correct)

SHIFT **DEL** 6.

4 **DATA** 5 **DATA** 5.

④' (To correct)

2 **DATA** 4 **SHIFT** **DEL** 4.

2 **DATA** 5 **DATA** 5.

These ways of correction can also be applied to logarithmic, exponential or power regression.

■ Logarithmic regression

Formula: $y = A + B \cdot \ln x$

- * Input data items are the logarithm of x ($\ln x$), and y which is the same as in linear regression.
- * Operation for calculating and correcting regression coefficients are basically the same as in linear regression. Operate the sequence $x \rightarrow \ln \rightarrow y$ to obtain estimator $\hat{y}$ and $y - \hat{y}$ for estimator $\hat{x}$. Note that $\sum \ln x$, $\sum (\ln x)^2$, and $\sum \ln x \cdot y$ are obtained instead of $\sum x$, $\sum x^2$, and $\sum xy$ respectively.

Ex.)	x_i	29	50	74	103	118
	y_i	1.6	23.5	38.0	46.4	48.9

Find A , B , r , $\hat{x}$ and $\hat{y}$ using the above figures as a basis.

“LR”

SHIFT KAC 29 (IN) X ₂	3.36729583
1 6 (DATA)	1.6
50 (IN) X ₂ 23 5 (DATA)	23.5
74 (IN) X ₂ 38 (DATA)	38.
103 (IN) X ₂ 46 4 (DATA)	46.4
118 (IN) X ₂ 48 9 (DATA)	48.9
SHIFT A	- 111.1283963

(A)

SHIFT B 34.02014719

(B)

SHIFT R 0.994013942

 $\{r\}$

(When x_i is 80) $80 \ln 2$ 37.9487947

(9)

(When y_i is 73) 73 224.1541338

(f)

■ Exponential regression

Formula: $y = A \cdot e^{B \cdot x}$

- Input data items are the logarithm of y ($\ln y$), and x which is the same as in linear regression.
- Operation for correction is basically the same as in linear regression. Operate $\frac{\sum \ln y}{n}$ for estimator $\hat{\beta}$, and $y \ln \frac{\sum y}{n}$ for estimator $\hat{x}$. Note that $\sum \ln y$, $\sum (\ln y)^2$, and $\sum x \cdot \ln y$ are obtained instead of $\sum y$, $\sum y^2$, and $\sum xy$.

Ex.)	x_i	6.9	12.9	19.8	26.7	35.1
	y_i	21.4	15.7	12.1	8.5	5.2

Find A , B , r , $\hat{x}$ and $\hat{y}$ using the above figures as a basis.

“LR”

SHIFT KAC 6 • 9 ZAN	6.9
21 • 4 (IN) DATA	3.063390922
12 • 9 ZAN 15 • 7 (IN) DATA	2.753660712
19 • 8 ZAN 12 • 1 (IN) DATA	2.493205453
26 • 7 ZAN 8 • 5 (IN) DATA	2.140066164
35 • 1 ZAN 5 • 2 (IN) DATA	1.648658626
SHIFT A SHIFT e ^x	30.49758743

(A)

SHIFT B - 0.049203708

(B)

SHIFT r - 0.997247351

(r)

(When x_i is 16) 16 13.87915739

(9)

(When y_i is 20) 20 $\ln$ SHIFT $\frac{1}{x}$ 8.574868054

(f)

■ Power regression

Formula: $y = A \cdot x^B$

*Input data items are ln_x and ln_y .

*Operation for correction is basically the same as in linear regression. Operate $\boxed{\text{SHIFT}} \boxed{A} \boxed{\text{SHIFT}} \boxed{e^x}$ to obtain coefficient A, $x \boxed{\text{IN}} \boxed{2} \boxed{\text{SHIFT}} \boxed{e^x}$ for estimator $\hat{\beta}$, and $y \boxed{\text{IN}} \boxed{\text{SHIFT}} \boxed{2} \boxed{\text{SHIFT}} \boxed{e^x}$ for estimator $\hat{x}$. Note that $\Sigma \ln x$, $\Sigma (\ln x)^2$, $\Sigma \ln y$, $\Sigma (\ln y)^2$, and $\Sigma \ln x \cdot \ln y$ are obtained instead of Σx , Σx^2 , Σy , Σy^2 and Σxy respectively.

Ex.)	x_i	28	30	33	35	38
	y_i	2410	3033	3895	4491	5717

Find A , B , r , $\hat{x}$ and $\hat{y}$ using the above figures as a basis.

"LR"

SHIFT	KAC	28	IN	Σ _{AB}	3.33220451
		2410	IN	DATA	7.787382026
30	IN	Σ _{AB}	3033	IN	DATA
					8.017307508
33	IN	Σ _{AB}	3895	IN	DATA
					8.267448958
35	IN	Σ _{AB}	4491	IN	DATA
					8.409830673
38	IN	Σ _{AB}	5717	IN	DATA
					8.651199471
SHIFT	A	SHIFT	e ^x		0.238801299

(A)

SHIFT B 2.771865947

(B)

SHIFT F 0.998906243

(f)

(When xi is 40) 40 ln SHIFT e^x 6587.67572

(y)

(When yi is 1000) 1000 ln SHIFT e^x 20.2622555

(x)

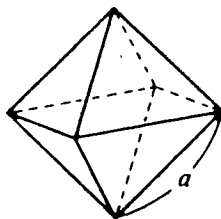
11/PROGRAMMED CALCULATIONS

- * This calculator has a program memory of 38 steps. Up to two programmed procedures of calculation may be stored in the memory.
- * To store a program (mathematical procedure) in the calculator, execute ordinary (i.e. manual) calculation in the LRN mode (press **MODE** **EXP**) only once.
- * Now the calculator has memorized the program. Input data and press the **RUN** key, and the calculator executes the program with the data. This is very convenient for repeating calculations with varying sets of data.

How to store and execute programs

Ex. 1) Calculate the surface areas (S) of regular octahedrons whose ridges are respectively 10, 7 and 15 cm long.

Formula: $S = 2\sqrt{3} a^2$



Ridge length (a)	Surface area
10 cm	(346.41) cm ²
7	(169.74)
15	(779.42)

*Values enclosed with parentheses are to be obtained.

- The following sequence of key operations realizes a mathematical procedure of the above formula.

2 X 3 **✓** X 10 **SHIFT** **X²** **=** → S

↑
Value of a (data)

- Operate the above sequence in the LRN mode (**MODE** **EXP**). Note that **ENT** must be pressed prior to data entry (the value of a in this case).

(Select LRN mode)

MODE **EXP** LRN P1 P2 0.

LRN and P1, P2 lit.

(Designate program No.)

P1 LRN P1 0.

Select a program area P1 or P2.

2	LRN	P1	2.
X	LRN	P1	2.
3	LRN	P1	3.
✓	LRN	P1	1.732050808
X	LRN	P1	3.464101615
ENT	LRN	P1	10. XY
SHIFT	X ²		100.
=	LRN	P1	346.4101615

S for a = 10

(Input data)

*The mathematical procedure is stored in P1.

Execution of the program stored

(Select RUN mode)

MODE ***** 346.4101615 (LRN disappears)

(Designate program No.)

P1 3.464101615 **XY**
7 **RUN** 169.7409791

S for a = 7

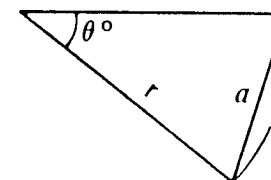
P1 15 **RUN** 779.4228634

S for a = 15

Ex. 2) Calculate the length, ℓ of the arc and the length, a of the chord of a sector with radius and radii making an angle of θ°

$$\ell = \frac{\pi r \theta}{180}$$

$$a = 2r \sin \frac{\theta}{2}$$



Radius (r)	Angle of radii (θ)	Arc length (ℓ)	Chord length (a)
10 cm	60°	(10.47) cm	(10) cm
12	42°34'	(8.91)	(8.71)
15	36°	(9.42)	(9.27)

*The values enclosed with parentheses are to be obtained.

(Select LRN mode)

MODE EXP LRN P1 P2
0.

(Designate program No.)

P2 LRN P2
0.
MODE 4 ENT 10 LRN P2
10.

r → To K1 register

Kin 1 X ENT 60 LRN P2
60.

θ → To K2 register

Kin 2 X π $\div$ 180 = SHIFT HLT LRN P2
10.47197551

HLT for displaying result (ℓ)

2 Kin X 1 Kin $\div$ 2 K1 $\times$ 2, K2 $\div$ 2

Kout 2 sin Kin X 1 $\sin \frac{\theta}{2} \times K1$

Kout 1 LRN P2
10.

Result (a)

Execution of the program stored.

(Select RUN mode)

MODE (LRN disappears)
10.

(Designate program No.)

P2 LRN P2
10.

(Input r)

12 RUN LRN P2
12.

(Input θ)

42 34 RUN LRN P2
8.915141819

Result (ℓ)

(Subsequently)

RUN 8.711524731

Result (a)

P2 15 RUN 36 RUN 9.424777961

Result (ℓ)

RUN 9.270509831

Result (a)

(Subsequently)

■ Program step

•The program is stored (written) in the calculator as shown below.

No. of steps	Program	No. of steps	Program
1	P1 2	15	$\times$
2	$\times$	16	π
3	3	17	$\div$
4	$\sqrt{}$	18	1
5	$\times$	19	8
6	ENT	20	0
7	SHIFT x^2	21	=
8	=	22	SHIFT HLT
9	P2 MODE 4	23	2
10	ENT	24	Kin $\times$ 1
11	Kin 1	25	Kin $\div$ 2
12	$\times$	26	Kout 2
13	ENT	27	sin
14	Kin 2	28	Kin $\times$ 1
		29	Kout 1

•The program capacity is 38 steps. The program may be divided into two areas (P1 and P2) and each can be used independently of the other.

•An error results ("E" displayed) when there is an attempt to write the 39th step. No subsequent steps can be written. In this case, press AC to release the error check.

•After the program is started, instruction steps are executed one after another and execution does not stop. But it is needed to halt execution for inputting a data or reading a result. This is accomplished by ENT and SHIFT HLT.

When the end of a program is reached, execution stops automatically and the state is displayed. So, HLT may be absent.

•Each function comprises a step of program. The depression of keys in a certain sequence produces a single program step if it generates a single function.

1) Functions generated by the depression of a single key

Ex.) Numeral value, $+/-$, $+$, $-$, $\times$, $\div$, $=$, $[(,)]$, sin, log, ENT, ...

- * If you have misoperated when writing a program (i.e. in the LRN mode), press the sequence of **SHIFT** **DEL** and perform the correct operation.
- * The depression of a data entry key (**□**, **0** — **9**) followed by **EXP**, **1/x**, **1/y** or **C** will not be written in if such a sequence immediately follows the depression of **ENT**. Note that one of the functions which does not follow a numeric data will be written in as a step

■ How to erase a program

- To erase a single program (P1 or P2).

- To erase both P1 and P2.

■ Jump instructions

1. Unconditional return to the first step of program: RTN

Write the sequence of **SHIFT** **RTN** at the end of a program to execute it repeatedly.

Ex.) Let us use the unconditional return instruction in the regular octahedron program: $x \leq M$: Return to the first step of program if the contents of the X-register is equal to or smaller than the contents of the M-register and otherwise go to the next step. (In this case, the formula must be modified to $S = a^2 \times 2\sqrt{3}$.)

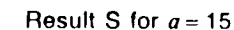
Step No.	Instruction step
1	ENT
2	SHIFT x^2
3	$\times$
4	2
5	$\dot{\times}$
6	3
7	$\sqrt{\quad}$
8	=
9	SHIFT RTN



(Designate program No.)

(For $a = 7$)

(For $a = 15$)



*If a program includes an RTN instruction but neither ENT nor HLT, the program will, once started, not stop in an endless loop. To stop the program in such a case, press **AC**.

2. Return to the first step of program depending on the condition of the contents of the X-register (display): $x > 0$, $x \leq M$

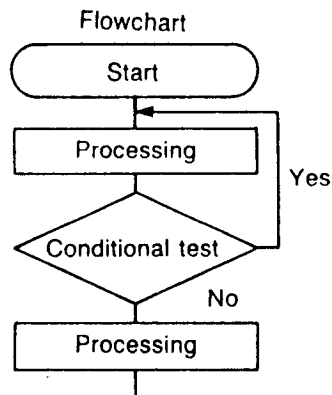
x > 0: Return to the first step of program if the contents of the X-register is greater than zero and go to the next step otherwise.

pr x $\leq$ M: Return to the first step of program if the contents of the X-register is equal to or smaller than the contents of the M-register and otherwise go to the next step.

Ex.) Find the maximum of 456, 852, 321, 753, 369, 741, 684 and 643.

Operation: **MODE** **EXP** **P1**
ENT **SHIFT** **$\times \div$** **SHIFT** **Min**

Step No.	Instruction step
1	ENT
2	SHIFT $x \leq M$
3	SHIFT Min



MODE $\cdot$ AC SHIFT Min 0.

Memory cleared

(Designate P1)

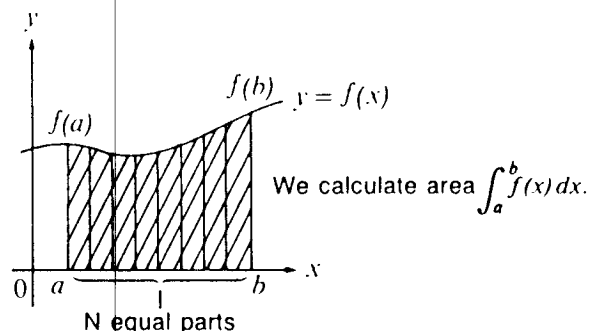
(Input data)

	P1	0.
456	RUN	456.
P1 852	RUN	852.
P1 321	RUN	321.
753	RUN	753.
369	RUN	369.
741	RUN	741.
684	RUN	684.
643	RUN	643.
MR		852.

Maximum displayed

12/INTEGRALS

*To carry out integrals, ① define (write) function $f(x)$ during the LRN mode, then ② designate the interval of integral during the $\int dx$ mode.



*The approximation method used for integrating the function written in P1 or P2 is the Simpson's rule. This method requires to divide the interval of integral into equal parts. If the number of divisions is not specified, the calculator determines it by itself according to the form of the function. To specify it, designate n (an integer of 1 to 9) which meets $N=2^n$ where N is the number of divisions.

■ Defining function $f(x)$

- 1) Select the LRN mode (press MODE EXP).
- 2) Designate a program number (press P1 or P2).
- 3) Press SHIFT Min .

*This is needed, as the first program step, to assign variable x of the function $f(x)$ to the M-register.

- 4) Write the expression of function $f(x)$ by true algebraic logic. Use MR to represent variable x . Write = at the end.

Ex.) For $f(x) = \frac{1}{x^2 + 1}$, write the sequence of 1, $\div$, $\left[\left(\text{MR}, \text{SHIFT } x^2, +, 1, \right) \right]$, $=$.

- 5) Press MODE 1 to select the $\int dx$ mode.

Note: For a function $f(x)$ whose variable x cannot take the zero value, input an appropriate number in between steps 1) and 2) above.

Do not use constant registers, RAC , ENT and RLT during expressing a function (step 4).

■ Execution of integral

- 1) Select the $\int dx$ mode (press MODE 1).
- 2) Designate the program number assigned to the function, $f(x)$, (Press P1 or P2).
- 3) Press a sequence of n SHIFT RUN to specify division number N (this will be displayed). This step may be skipped.
- 4) Designate the interval of integral, $[a, b]$. (Press a RUN b RUN .)

*In seconds or minutes the result will be displayed in a floating point representation.

At this time the memory registers contain the following data.

K1-register (Press **[Kout]** **[1]**) a
 K2-register (Press **[Kout]** **[2]**) b
 K3-register (Press **[Kout]** **[3]**) $N (= 2^n)$
 K4-register (Press **[Kout]** **[4]**) $f(a)$
 K5-register (Press **[Kout]** **[5]**) $f(b)$
 K6-register (Press **[Kout]** **[6]**) $\int_a^b f(x) dx$
 M-register (Press **[MR]**) a

Ex.) For $f(x) = 2x^2 + 3x + 4$, calculate $\int_2^5 f(x) dx$ and $\int_2^8 f(x) dx$.

(Select LRN mode) **[MODE]** **[EXP]** **[LRN]** **[P1]** **[P2]** **[0.]**
 (Designate program No.) **[P1]** **[LRN]** **[P1]** **[0.]**
[SHIFT] **[Min]** **[LRN]** **[P1]** **[0.]**
 (Write $f(x)$) **2** **[X]** **[MR]** **[SHIFT]** **[x²]** **+** **3** **[X]** **[MR]** **+** **4** **[=]**

Writing $f(x)$

(Select $\int dx$ mode) **[MODE]** **[1]** **[$\int dx$]** **[4.]**
 (Designate program No.) **[P1]** **[$\int dx$]** **[P1]** **[0.]**
 (Input n) **2** **[SHIFT]** **[RUN]** **[$\int dx$]** **[P1]** **[4.]**
 (Input a and b) **2** **[RUN]** **5** **[RUN]** **[$\int dx$]** **[1.21500000]** **[0 2]**
 Result displayed in about 4 seconds

$\int_2^5 f(x) dx$

(Designate program No.) **[P1]** **[$\int dx$]** **[P1]** **[0.]**
 (Input a and b) **2** **[RUN]** **8** **[RUN]** **[$\int dx$]** **[4.50000000]** **[0 2]**
 Result displayed in about 6 seconds

$\int_2^8 f(x) dx$

[Kout] [1]	$\int dx$	2.	a
[Kout] [2]	$\int dx$	8.	b
[Kout] [3]	$\int dx$	8.	N
[Kout] [4]	$\int dx$	18.	$f(a)$
[Kout] [5]	$\int dx$	156.	$f(b)$
[Kout] [6]	$\int dx$	450.	$\int_a^b f(x) dx$

■ Remarks for execution of integrals

*If you press **[AC]** during execution of integral (nothing is displayed), the execution will be aborted and the state selected by the depression of **[MODE]** **[1]** entered.

*If no function $f(x)$ is defined (written in), the calculator will carry out integral for $f(x) = x$.

*It is normal to set the angular mode to "**[$\square$]**" when executing integral of trigonometrics.

*Integral approximated by the Simpson's rule may take much execution time to raise the accuracy of result. Error may be large even when much execution time has been consumed. If the number of significant digits of result is smaller than one, error termination occurs ("E" displayed).

In such cases, dividing the integral interval will reduce execution time and raise accuracy:

1. If the result varies greatly when the integral interval is moved slightly:
Divide the interval into sections and sum up the results obtained in the sections.

2. For a periodic function or if the value of integral becomes positive or negative depending on the interval:
Calculate for each period or separately for the sections where the result of integral is positive from where the result is negative, and sum up the results obtained.

3. If long execution time is due to the form of the function defined:
Divide the function, if possible, into terms, execute integral for each term separately, and sum up the results.

13/SPECIFICATIONS

BASIC OPERATIONS

4 basic calculations, constants for $+$ $-$ $\times$ $\div$ x^y $x^{1/y}$ AND/OR/XOR/XNOR, parenthesis calculations and memory calculations.

BUILT-IN FUNCTIONS

Trigonometric/inverse trigonometric functions (with angle in degrees, radians or grads), hyperbolic/inverse hyperbolic functions, common/natural logarithms, exponential functions (common antilogarithms, natural antilogarithms), powers, roots, square roots, cube roots, squares, reciprocals, factorials, conversion of coordinate system ($R \rightarrow P$, $P \rightarrow R$), permutations, combinations, random number, π , fractions, percentages, binary, octal, decimal and hexadecimal calculations and logical operations.

STATISTICAL FUNCTIONS

Standard deviation, linear regression, logarithmic regression, exponential regression, and power regression.

INTEGRALS

Simpson's rule.

MEMORY

1 independent memory and 6 constant memories.

CAPACITY

Entry/basic calculations

10-digit mantissa, or 10-digit mantissa plus 2-digit exponent up to $10^{\pm 99}$

Fraction calculations

Total of integer, numerator and denominator must be within 10 digits (includes division marks).

Scientific functions

Input range

$\sin x / \cos x / \tan x$	$ x < 9 \times 10^9 \text{ degrees } (< 5 \times 10^7 \pi \text{ rad, } < 10^{10} \text{ gra})$
$\sin^{-1} x / \cos^{-1} x$	$ x \leq 1$
$\tan^{-1} x$	$ x < 10^{100}$
$\sinh x / \cosh x$	$ x \leq 230.2585092$
$\tanh x$	$ x < 10^{100}$
$\sinh^{-1} x$	$ x < 5 \times 10^{99}$
$\cosh^{-1} x$	$1 \leq x < 5 \times 10^{99}$
$\tanh^{-1} x$	$ x < 1$
$\log x / \ln x$	$10^{-99} \leq x < 10^{100}$
e^x	$-10^{100} < x \leq 230.2585092$
10^x	$-10^{100} < x < 100$
x^y	$\begin{cases} x > 0 \rightarrow -10^{100} < y \cdot \log x < 100 \\ x = 0 \rightarrow y > 0 \\ x < 0 \rightarrow y : \text{integer or } 1/2n + 1 \text{ (} n : \text{integer)} \end{cases}$
$x^{1/n}$	$\begin{cases} x > 0 \rightarrow y \neq 0 \text{ } -10^{100} < 1/y \cdot \log x < 100 \\ x = 0 \rightarrow y > 0 \\ x < 0 \rightarrow y : \text{odd number or } 1/n \text{ (} n : \text{integer)} \end{cases}$
$\sqrt{x}$	$0 \leq x < 10^{100}$
x^2	$ x < 10^{50}$
$\sqrt[3]{x}$	$ x < 10^{100}$
$1/x$	$ x < 10^{100} \text{ (} x \neq 0 \text{)}$
$x!$	$0 \leq x \leq 69 \text{ (} x : \text{integer)}$
nPr / nCr	$0 \leq r \leq n, n < 10^{10} \text{ (} n, r : \text{positive integer)}$

*Certain combinations or permutations may cause errors due to overflow during internal calculations.

$$\sqrt{x^2 + y^2} < 10^{100}$$

$$|\theta| < 9 \times 10^9 \text{ degrees } (< 5 \times 10^7 \pi \text{ rad, } < 10^{10} \text{ gra}),$$

$$0 \leq r < 10^{100}$$

0.000

up to second

r

10 digits

*Output accuracy

± 1 in the 10th digit.

Binary

Positive : $0 \leq x \leq 111111111$

Negative: $1000000000 \leq x \leq 1111111111$

Octal

Positive : $0 \leq x \leq 3777777777$

Negative: $4000000000 \leq x \leq 7777777777$

Decimal

Positive : $0 \leq x \leq 2147483647$

Negative: $-2147483648 \leq x < 0$

Hexadecimal

Positive : $0 \leq x \leq 7FFFFFFF$

Negative: $80000000 \leq x \leq FFFFFFFF$

*Errors are cumulative with such internal continuous calculations as $x^y, x^{1/y}, x!, \sqrt[n]{x}, nPr, nCr$ so accuracy may be adversely affected.

*In $\tan x$, $|x| \neq 90^\circ \times (2n+1)$, $|x| \neq \pi/2 \text{ rad} \times (2n+1)$, $|x| \neq 100 \text{ gra} \times (2n+1)$ (n is an integer.)

*With $\sinh x$ and $\tanh x$, errors are cumulative and adversely affected when $x = 0$.

PROGRAMMABLE FEATURES

Total number of steps: up to 38 (1 step performs a function).

Jump: Unconditional jump (RTN), Conditional jump ($x > 0, x \leq M$).

Number of programs storable: up to 2 (P1 and P2).

DECIMAL POINT

Full floating with underflow.

EXPONENTIAL DISPLAY

Norm 1 — $10^{-2} > |x|, |x| \geq 10^{10}$

Norm 2 — $10^{-9} > |x|, |x| \geq 10^{10}$

READ-OUT

Liquid crystal display, suppressing unnecessary 0's (zeros).

POWER SOURCE

Power source: Amorphous silicon solar cell, lithium battery (GR927)

Lithium battery life: 6 years with GR927 (1-hour daily use).

AMBIENT TEMPERATURE RANGE

$0^\circ\text{C} - 40^\circ\text{C}$ ($32^\circ\text{F} - 104^\circ\text{F}$)

DIMENSIONS

$8.5\text{mmH} \times 73\text{mmW} \times 140\text{mmD}$ ($3/8''\text{H} \times 27/8''\text{W} \times 5 1/2''\text{D}$)

WEIGHT

60 g (2.1 oz)

REC → POL

POL → REC